REPORT OF THE MICROSPACECRAFT PANEL

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1 NTRODUCTI ON

These findings and recommendations are based solely on the material presented during the Microtechnologies and Applications to Space Systems Workshop, 5/27 & 28/92, and the personal knowledge and judgment of the panel members. These findings and recommendations represent the consensus views of the committee. 'I'he mission utility of microspacecraft for NASA space science missions was not an issue that t-he panel addressed. For the purposes of this panel, a microspacecraft was defined to be a fully functional spacecraft., intended for use on NASA space science missions, whose mass is on the order of 10 kg. During the panel discussions the microspacecraft mass definition was used somewhat loosely to be not less than 10 kg but certainly not more than 100, dependent. upon the mission requirements.

PANEL SCOPE

'l'he scope of the panel is presented here in order to put the panel report into context..

> "The panel report wi]] attempt to identi fy areas that need additional development to enable a microspacecraft for NASA space science missions. These areas will span technology development through space qualification of the microspacecraft system. 'l'he panel will deal with two top level issues: 1) integrating advances in technology into the microspacecraft system and 2) identifying present. limits of obstacles to achieving a microspacecraft. These limits or obstacles will be further defined as either fundamental or only based upon the present state of" technology, and therefore a fertile area for improvement with increased resources. The panel will be concerned with all spacecraft. subsystems, i.e., instruments, power, propulsion, attitude control, command & data, telecommunications, thermal and structure/cabling/mechani sms."

The scope of the panel evolved somewhat from the above during the discussions on 5/29. Contrary to the what is written above, the panel did not concern itself specifically with (science) instruments.

FINDINGS

1) The panel identified no fundamental engineering or physics limitations that. would preclude the construction of a microspacecraft.

2) There is a large amount of available technology (up to technology readiness level (TRL) 7 which can support microspacecraft given the proper amount of design, validation and qualification.

   2a) Some of this technology can be directly and immediately applied to microspacecraft and some will require modification to NASA needs.

   2b) This same technology can also be applied to the larger NASA space systems.

3) The majority of the technology that can support microspacecraft is programmatically located in the DOD (SD10, DARPA, etc.) and their contractors.

4) There are certain spacecraft components that. could be applied to or may be required for certain NASA space science microspacecraft and that have not been addressed by the DOD. Foremost among these components are micro-RTGs, electric propulsion and telecommunications equipment developed for the frequencies used by NASA.

5) The following subsystem/box level technologies (see table 1) can support a microspacecraft and are relatively mature (up to TRL 7) in the DOD community .

6) Microspacecraft have certain unique technical challenges/needs at the system integration level (see table 2).

7) The panel's assessment is that the first application of Micro Electro Mechanical Systems (MEMS) technology to microspacecraft will probably be in the area of' sensors (e.g. pressure and temperature), and micro gyros and micro-accelerometers.

Table 1
Technologies Resident at DOD Contractors
that Could Support a NASA Microspacecraft

Structures/Mechanisms

shaped memory actuators - d
composite sandwich panel & trusses (metal & polymer matrix composites) - d
high thermal conductivity composites & phase change material - d

Power

high efficiency solar cells - d
high energy density battery cells - m

Command and Data

data compression - d/m
opto electronics - m
high capacity bulk data storage parts - d

Telecommuni cations

active arrays - m
digital receivers - m
Ka band and higher frequencies -m
optical communications - m

Attitude Control

fiber optic and ring laser gyros - d
miniature star cameras/trackers - d
lightweight reaction/momentum wheels - d

j'repulsion

mono and bi-prop engines - m
high pressure fiber overwrapped propellant. & pressurant tanks -- d
lightweight valves and regulators - m/d

Electronic Packaging

surface mount technology - d
multichip modules - d
3-D packaging - d
wafer scale integration - m
MMIC - d

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d = can be directly applied to NASA microspacecraft (may require re-qualification for a NASA mission)
m = requires modification and qualification for NASA needs

Table 2

System Level Technology issues Unique to Microspacecraft

1) improved/Re-partitioned system architectures

2) minimization of interconnections (e.g. cabling/connectors)

3) common mechanical/electrical/thermal packaging

4) power distribution and use at lower system voltages

RECOMMENDATI ONS TO NASA
(ranked according to priority)

1) Establish a program to flight demonstrate microspacecraft.

   1a) Vigorously pursue the transfer, qualification and insertion of DOD developed technologies (defined in finding #5) to NASA missions, systems and subsystems.

   1b) In cooperation with NASA codes SL, SS, SZ, SE and QE, support system/mission studies of' the microspacecraft concept with the goal of more effectively presenting the applications, requirements and pros and cons of mi.crospacecraft.

   1c) Support the development of" microspacecraft technologies which are either unique to microspacecraft or which have not been supported by the DOD (defined in findings # 4 & 6).

2) Support the MEMS community with a small ($0.5) program and encourage investigations into NASA applications.

3) Convene a microspacecraft working group to increase communication between users and technologists. This working group should consist of representatives from NASA user centers, NASA technology centers, codes R, S and Q and the DOD contractor community.